Unit 07

BIOENERGETICS

Q.1. What do you know about energy of living organisms? Give its forms?

Ans. A living cell exhibits ceaseless chemical activities. Substances are broken down inside the cells and new substances are formed. Energy drives all these processes in a cell.

Energy exists in two forms in living organisms:-

(i) Kinetic Energy

It is actively involved in doing work.

(ii) Potential Energy

The potential energy is stored in chemical bonds. It is used for future use. It is released as kinetic energy when these bonds break.

Q.2. Describe bioenergetics and the role of ATP.

Ans. Definition

Bioenergetics is the study of energy relationships and energy transformations (conversions) in living organisms.

Explanation

Organisms obtain energy by metabolizing the food they eat or prepare. Food contains potential energy in its bonds. When these bonds are broken down, a large amount of kinetic energy is released. Some of this energy is stored in the form of potential energy in the bonds of ATP molecules while the rest escapes as heat. The potential energy stored in ATP is again transformed into kinetic energy to carry out the life activities.

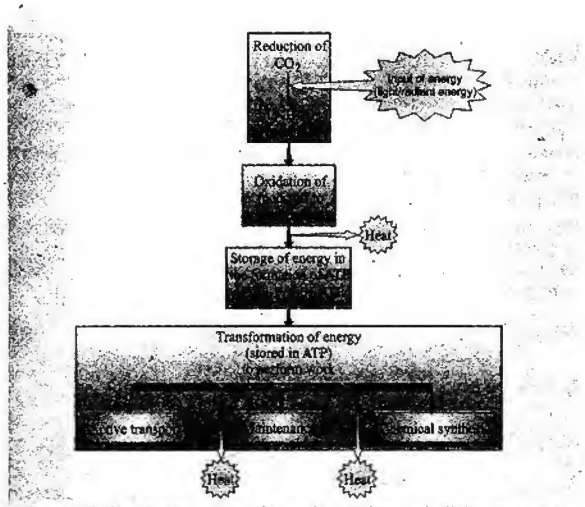


Figure 7.1: Some energy transformation pathways in living systems. Note that heat is lost in every transformation

Q.3. (a) How would you define bioenergetics while relating it to the oxidation-reduction reactions in living systems?

(b) How electrons act as an energy source?

Ans. (a) Bioenergetics:

Definition: Bioenergetics is the study of energy relationships and energy transformations in living organisms.

Oxidation Reduction Reactions in Living Organisms:

For all life processes, oxidation reduction reactions are the direct source of energy. Oxidation reduction reactions involve exchange of electrons between atoms.

Oxidation: In oxidation reaction, loss of electrons while in **Reduction** the gain of electrons takes place.

These reactions always run simultaneously and are also called **Redox reactions**.

Processes involved in Energy Flow:

The various life processes in organisms involve constant flow of energy. This energy flow comprises the acquisition, transformation and use of energy like

(i) Growth

(ii) movement

(iii) reproduction etc.

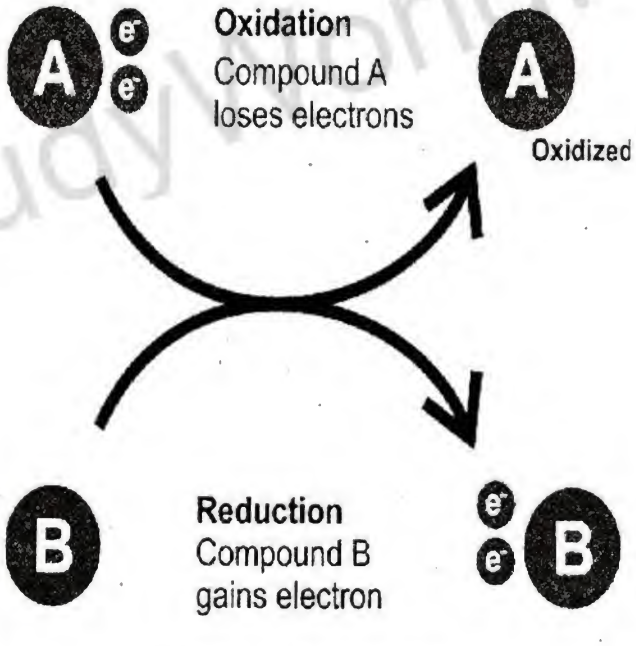


Figure 7.2:

(b) Electrons as an Energy Source:

Electrons can be an energy source. It depends upon their:

(i) Location in atoms

(ii) Arrangement in atoms

Example: When electrons are present in oxygen, they make stable association with oxygen atom and are not good energy source.

But if electrons are dragged away from oxygen and attached to some other atom e.g. carbon or hydrogen, they make unstable association. They try to move back to oxygen and when this happens, energy is released. In this way, electrons act as an energy source.

Redox reactions in living organisms

In living organisms, redox reactions involve the loss and gain of hydrogen atoms. It means that when a molecule loses a hydrogen atom, it actually loses an electron and similarly when a molecule gains hydrogen atom, it actually gains an electron.

Q4.(a) Interpret that ATP is the chief energy currency of all cells.

(b) Describe the molecular structure of ATP.

Ans. (a) ATP: The Cell's Energy Currency:

The major energy currency of all cells is a nucleotide called ATP (Adenosine triphosphate).

Discovery: ATP was discovered by Karl Lohmann in 1929.

It was proposed to be the main energy transfer molecule in the cell by Nobel Prize winner, Fritz Lipmann in 1941.

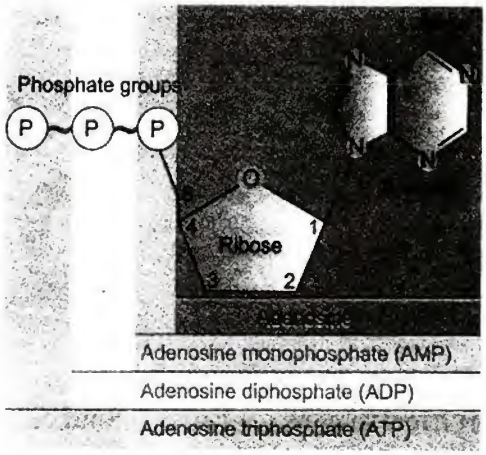
ATP: The main energy source in cellular functions:-

ATP is the main energy source for majority of the cellular functions like the:

(i) Synthesis of macromolecules (DNA, RNA, proteins)
(ii) Movement
(iii) Transmission of nerve impulses
(iv) Active transport
(v) Exocytosis and Endocytosis

Value of energy:

The energy released when one phospohate bond is broken is 7.3 k cal/mol or 7300 calories per mole of ATP.



(Figure 7.3) olecular structure of Adenosine Triphosphate (ATP)

Ans (b). Molecular Structure of ATP:

Subunits in ATP molecule:

Each ATP molecule has three subunits.

(i) Adenine: a double ringed nitrogenous base.
(ii) Ribose: a five-carbon sugar.
(iii) Three phosphate groups in a linear chain.

Covalent Bond in ATP:

The covalent bond connecting two phosphates is indicated by the "tilde" (~) and it is a high energy bond.

Energy value:

The energy in this bond is released as it breaks and inorganic phosphate (Pi) gets separated from ATP.

The breaking of one phosphate bond releases about 7.3 k cal (7300 calories) per mole of ATP.

$$ATP + H_2O \longrightarrow ADP + Pi + energy\ (7.3\ kcal/mol)$$

Q.5. (a) What do you know about energy values during the breaking of ATP?

Ans. Breakdown of ATP to AMP occurs in the following way:-

(i) Breakdown of ATP to ADP:

In common energy reactions, only the outermost of the two high energy bonds break. When this happens, ATP becomes ADP and one Pi is released.

$$ATP + H_2O \longrightarrow ADP + Pi + energy(7.3kcal/mol)$$

(ii) Breakdown of ADP to AMP:

In some cases, ADP is further broken down to AMP (Adenosine Monophosphate) and one Pi is released.

$$ADP + H_2O \longrightarrow AMP + Pi + energy(7.3kcal/mol)$$

(ii) ADP – ATP Cycle

Cells constantly recycle ADP by recombining it with Pi to form ATP. The synthesis of ATP from ADP and p_i requires the consumption of 7.3 k cal of energy per mole. So energy is used which is generated by energy releasing processes.

Q.6. (a) Define photosynthesis. Discuss it with its chemical equation.

(b) How the intake of water and CO_2 takes place for photosynthesis?

OR

Which phenomenon are involved in the intake of CO_2 and water by plants?

Ans. (a) Photosynthesis:

Definition:

The process by which plants and some other autotrophic organisms prepare their food (glucose) in the presence of sunlight and chlorophyll, with oxygen as a by-product is called photosynthesis.

Importance:

Photosynthesis is an anabolic process and is an important component of bioenergetics in living systems. It is the most important bio-chemical pathway and nearly all life depends on it.

Occurrence:

Photosynthesis occurs in plants, protists (algae) and some autotrophic bacteria.

Chemical Equation:

The chemical equation representing the process of photosynthesis is as follows;

$$6CO_2 + 12H_2O + \text{Light energy} \xrightarrow{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

Ans. (b) Intake of water and CO_2 for Photosynthesis:

Water and CO_2 are the raw materials of photosynthesis. The plants have mechanisms for the intake and transport of these materials.

Intake of water

Water present in soil is absorbed by roots and root hairs through osmosis. This water is eventually transported to leaves through xylem vessels.

(After the entry of water in the inner cells of the root, it reaches xylem vessels).

(ii) Intake of CO_2:

The air that enters the leaf through tiny pores (stomata) reaches into the air spaces present around mesophyll cells.

This air carries CO_2 which gets absorbed in the thin layer of water surrounding the mesophyll cells. From here, the CO_2 diffuses into the mesophyll cells.

Q.7. Describe the mechanism of photosynthesis in detail.

Ans. Phases in Photosynthesis:

Photosynthesis occurs in two phases;

(i) Light Reactions

In this phase, light energy is captured and is used to make high energy molecules ATP and NADPH. These reactions are known as light reactions. These take place on thylakoid membranes of chloroplast.

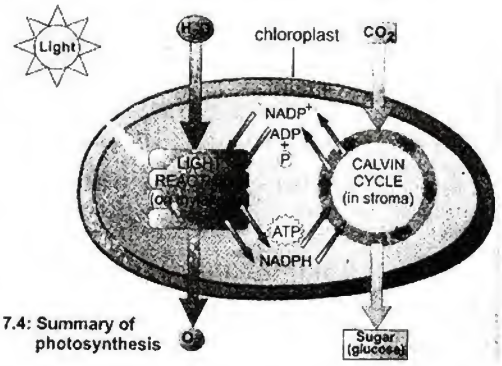


Figure 7.4: Summary of photosynthesis

(ii) Dark Reactions

It is second phase of photosynthesis in which carbon dioxide is reduced to make glucose. In this phase energy from high energy molecules (ATP and NADPH) is utilized. It takes place in the stroma of chloroplasts. Since these reactions do not use light directly, they are known as dark reactions.

(i) Light Reactions:

The reactions taking place during first phase of photosynthesis are called light reactions or light dependent reactions as they occur in the presence of light to make high energy molecules, ATP and NADPH.

Summary of Light Reactions:

The events that take place during the light reactions are as follows;

(i) Emission of electrons

When chlorophyll molecules absorb light, their energy level increases and their electrons are emitted.

(ii) Production of ATP:

Electrons are passed to Electron Transport Chains to produce ATP.

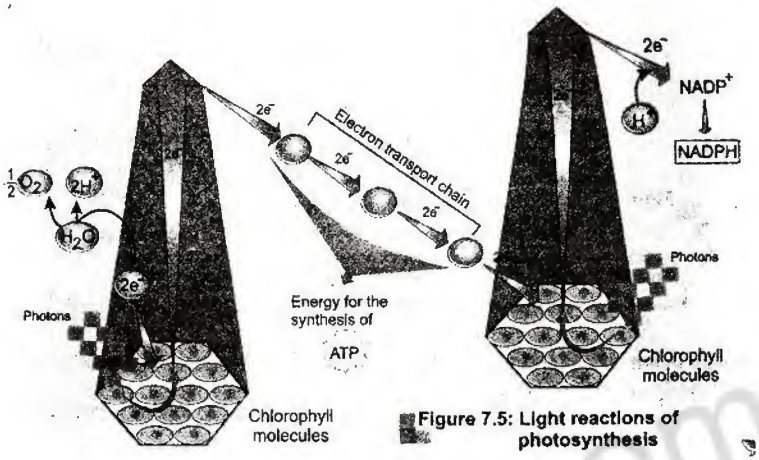


Figure 7.5: Light reactions of photosynthesis

(iii) Photolysis: (photo: light, lysis: break down)

Light breaks water molecule (photolysis) and oxygen is released. The hydrogen atoms of water give electrons to chlorophyll and become ions.

(iv) Reduction of $NADP^+$ to NADPH:

After the production of ATP, the electron of chlorophyll and the hydrogen ions of water are used for the reduction of $NADP^+$ into NADPH

Z - Scheme.

The whole series of light reactions is called Z-scheme due to its Z-shaped flow chart.

Dark Reaction:

Introduction

It is a light independent reaction which occurs at night.

Discovery: The details of dark reactions were discovered by Melvin Calvin and his Collegues at the University of California.

Due to this, summary of the events of dark reactions are also called Calvin Cycle.

(i) (a) Formation of 6-carbon compounds:

CO_2 molecules are combined with 5-carbon compounds to form temporary 6-carbon compounds.

(b) Splitting of 6-carbon compounds:

Each of 6-carbon compound splits into two 3-carbon compounds.

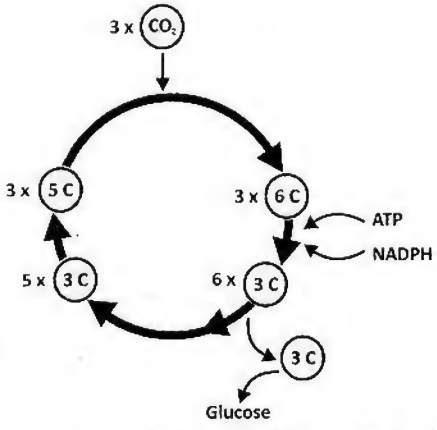


Figure 7.6: Dark reaction of photosynthesis (The Calvin cycle)

(ii) Reduction of 3-carbon compounds:

The 3-carbon compounds are reduced to 3-carbon carbohydrates by using ATP and hydrogen from NADPH.

The 3-carbon carbohydrates are used to manufacture glucose.

(iii) Regeneration of original 5-carbon compound:

The 3-carbon carbohydrates are also used to regenerate the original 5-carbon compound. This step utilizes ATP.

Q.8. Explain the role of chlorophyll and light in photosynthesis.

Ans. Role of Chlorophyll and light in Photosynthesis:

(i) Chlorophyll: sunlight is absorbed by chlorophyll. It is then converted into chemical energy which drives the photosynthetic process.

(ii) Only about one percent of the light falling on the leaf surface is absorbed, the rest is reflected or transmitted.

Photosynthetic Pigments:

(i) The light rays of different wavelengths are not only differently absorbed by photosynthetic pigments but are also differently effective in photosynthesis.

(ii) The blue and red lights carry out more photosynthesis which are absorbed by pigments.

Photosystems:

The photosynthetic pigments are organized in the form of clusters, called photosystems, in thylakoid membranes of chloroplasts.

Main Photosynthetic pigment:

Chlorophyll a is the main photosynthetic pigment.

Accessory Pigments:

Additional pigments like chlorophyll b and carotenoids are called accessory pigments. Some wavelengths not absorbed by chlorophyll 'a' are very effectively absorbed by accessory pigments and vice versa.

Q.9. Explain the limiting factors in photosynthesis. **(Lahore board 2011 G II)**

Ans. Limiting factors in photosynthesis:

Definition (Limiting Factors):

"Any environmental factor the absence or deficiency of which can decrease the rate of a metabolic reaction is called limiting factor"

Limiting Factors

(i) Light intensity
(ii) Temperature
(iii) Concentration of CO_2
(iv) Availability of water.

1) Effect of light Intensity:

The rate of photosynthesis varies with light intensity.

(i) It decreases as the light intensity decreases and increases as the intensity increases.

(ii) However at much higher light intensity, the rate of photosynthesis becomes constant.

2) Effect of Temperature: **(Lahore board 2012 G I)**

(i) The rate of photosynthesis decreases with decreases in temperature.

(ii) It increases as the temperature is increased over a limited range.

(iii)But if light intensity is low, increasing the temperature has little influence on the rate of photosynthesis.

3) Effect of Carbon dioxide Concentration:

(i) Carbon dioxide concentration raises the rate of photosynthesis, it goes on increasing until limited by other factors.

(ii) Increase in CO_2 concentration beyond a certain level causes the closure of stomata and it decreases the rate of photosynthesis.

Q.10. Define respiration. Describe its types and importance.

Ans. Respiration

Definition

In cellular respiration, food is oxidized to CO_2, H_2O and energy is released.

Explanation

Organisms utilize oxygen for the break down of C-H bonds present in the food in their cells. This yields energy. During this process, oxidation-reduction reaction breaks C-H bonds and so carbon dioxide and water are also produced. This cellular energy yielding process is called cellular repiration.

Types of respiration.

There are two methods of respiration.

(i) Aerobic respiration

(ii) Anaerobic respiration

(i) Aerobic respiration:

Definition:

It is that type of respiration in which complete oxidation of glucose occurs with maximum release of energy in the presence of oxygen.

First phase:

A molecule of glucose (6-C) is broken down into two molecules of pyruvic acid. (3-C)

Second phase:

Pyruvic acid is completely oxidized. All (C-H) bonds are broken and CO_2 and water is formed.

Equation

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{Energy}$

Glucose + Oxygen ⟶ Carbon dioxide + Water + Energy

(ii) Anaerobic respiration (Fermentation)

Definition

Some organisms oxidize their food incompletely without using any molecular oxygen called anaerobic respiration. Glucose is incompletely oxidized with less amount of energy released.

By this process less amount of energy is produced by one molecule of glucose.

Explanation

First Phase:

In anerobic respiration, the first phase is exactly similar to that of aerobic respiration. A molecule of glucose is broken down into two molecules of Pyruvic acid.

Second Phase:

In the second phase, Pyruvic acid is not completely oxidized. It is transformed into ethyl alcohol or lactic acid. In this way many of the C – H bonds are left unbroken in the products.

Types of anaerobic respiration:

Anaerobic respiration is further classified as:-

(i) Alcoholic fermentation. **(ii)** Lactic acid fermentation

(i) Alcoholic fermentation

It occurs in bacteria and yeast. In this type of anaerobic respiration, pyruvic acid is further broken down into alcohol (C_2H_5OH) and CO_2.

Pyruvic acid ⟶ Ethyl alcohol + carbon dioxide

(ii) Lactic acid fermentation

It occurs in skeletal muscles of humans and other animals during extreme physical activities. This also happens in the bacteria present in milk.

In this type each pyruvic acid molecule is converted into lactic acid ($C_3H_6O_3$)

Pyruvic acid ⟶ Lactic acid

Importance of anaerobic respiration

Importance of anaerobic respiration are as follows:-

(i) Early life

The earth in early time had environment which was totally devoid of oxygen. The organisms respire anaerobically to drive their energy. So life started on earth anaerobically.

(ii) Anaerobes

Some existing bacteria and Fungi live in oxygen free environment respire anareobically and called anaerobes.

(iii)Anaerobic respiration in active tissues

In some active tissues like skeletal muscles during exercise when oxygen supply can not keep pace with energy demand so anaerobic respiration provides energy by break down of glucose into lactic acid.

(iv)Uses of Fermentation

Scientists have used fermenting abilities of bacteria and fungi for benefit of mankind.

(i) Fermenting power of bacteria are used for making cheese and yogurt.

(ii) Fermentation in yeast is used in brewing and baking industries.

(iii) A fungus, Aspergillus is used to make soya sauce.

Q.11. Describe mechanism of respiration.

Ans. Mechanism of respiration

The process of respiration involves complex series of reactions. For the study of all the reactions of glucose oxidation, we will study the mechanism of aerobic respiration. Aerobic respiration is a continuous process but we can divide into three main stages.

(i) Glycolysis

(ii) Krebs cycle

(iii) Electron Transport chain

(i) Glycolysis

Location:

Glycolysis occurs in cytoplasm and oxygen is not involved at this stage so it occurs both in aerobic and anaerobic respiration.

Definition:

The process in which glucose molecule is broken into two molecules of pyruvic acids (3c).

(ii) Kreb's cycle

Discovery A British biochemist, Sir Hans Krebs discovered this series of reactions that is why it is called the krebs cycle

Definition: In Krebs cycle, pyruvic acid molecules are completely oxidized along with the formation of ATP, NADH and $FADH_2$.

Before entering in Krebs cycle, pyruvic acid is changed into a 2- carbon compound called acetyl COA.

(iii)Electron Transport chain

It is the final step of cellular respiration. It is the transfer of electron in an electron transport chain. In this step,

i. NADH and $FADH_2$ release electrons and hydrogen ions
ii. These electrons are taken up by a series of electron carriers.
iii. When electrons move, through the series of electron carriers they lose energy, which is used to synthesize ATP.
iv. At the end of chain, electrons and hydrogen ions combine with molecular oxygen and form water.

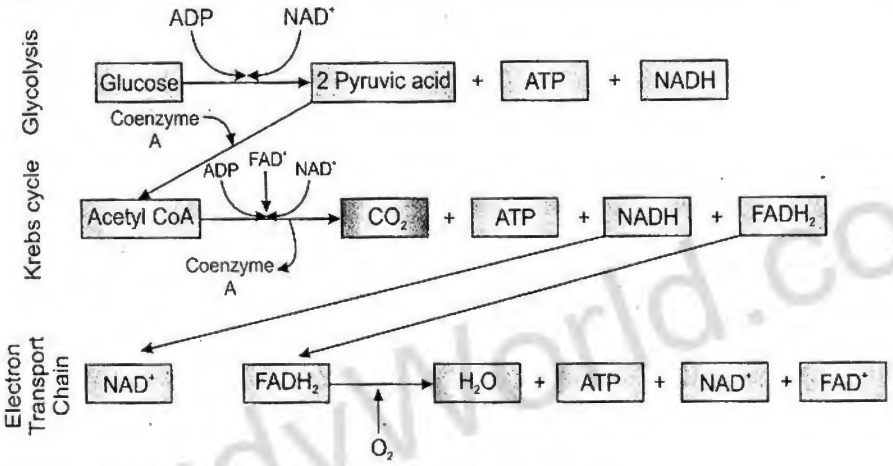


Figure 7.7: Mechanism of respiration

Q.12. Describe energy budget of respiration?

Ans. Energy budget of Respiration

Energy is produced in following steps.

(i) Each NADH molecule generated in glycolysis gives 2 ATP because 1 ATP is consumed to transport it across the mitochondrial membrane, and in krebs cycle and Electron Transport Chain produces 3ATP.

(ii) Each $FADH_2$ produces 2ATP

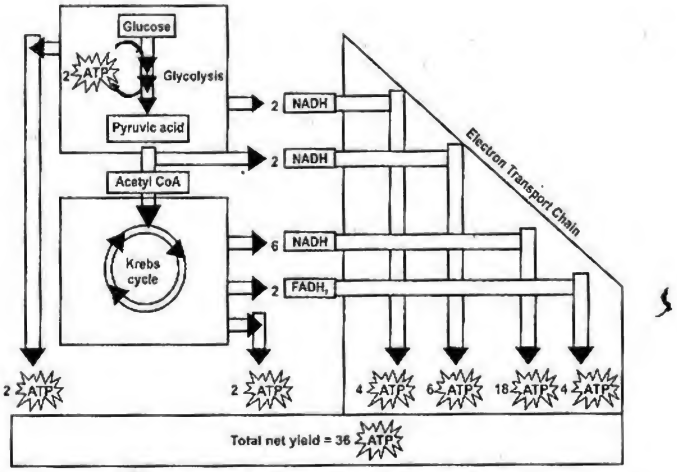


Figure 7.8: Energy chart of respiration

Total calculation from chart.
Total ATP molecules = 4 ATP
ATP from 10 NADH = 28 ATP
ATP from 2 FADH2 = 4 ATP

Total ATP = 36 ATP

Result: During anaerobic respiration oxidation of a glucose molecule produces 2 ATP as there is no krebs cycle and electron transport chain in anaerobic respiration. **(Lahore board 2012 G II)**

Table 7.1 Differences between aerobic and anaerobic respiration

Properties	Aerobic respiration	Anaerobic respiration
Presence of Oxygen	Yes	No
Number of ATP as net profit	36	2ATP
Final products	CO_2 , H_2O	Lactic acid or Ethanol + CO_2
Site of occurrence	Gycolysis in cytoplasm and Krebs cycle and electron transport chain in mitochondria	In cytoplasm
Importance	Major source of energy for most organisms	Source of energy for anaerobic organism Source of energy for aerobic organisms in short supply of O_2. Source of many products (ethanol, cheese etc)

Table 7.2 Differences between Photosynthesis and Respiration

Characteristics	Photosynthesis	Respiration
Metabolism	Anabolism	Catabolism
Energy investment / production	Investment of light energy to store it in the form of bond energy.	Bond energy transformed into chemical energy of ATP
Organisms capable of;	Some bacteria, all algae all chlorophyllous plants	All organisms
Site of occurrence	Chloroplasts	In cytoplasm and mitochondria
Time of occurrence	In daytime only, in the presence of light	All the time

Multiple Choice Questions

1. In which of the following steps of respiration, CO_2 is produced?
   (a) Glycolysis (b) Krebs cycle
   (c) electron transport
   (d) All of these
2. Oxygen takes part in aerobic respiration in
   (a) Glycolysis
   (b) link step between Glycolysis and krebs cycle
   (c) Krebs cycle
   (d) electron transport chain
3. When a plant was kept in darkness for many days, its leaves turned yellow. Why?
   (a) Leaves could not get oxygen and so there was no photosynthesis
   (b) Leaves could not get light and so there was no respiration
   (c) Leaves could not get oxygen and so there was no respiration
   (d) Leaves could not get light and so there was no photosynthesis.
4. From which bonds of ATP molecule, energy is taken?
   (a) P-P bonds (b) C-H bonds
   (c) C-N bonds (d) C-O bonds
5. In which component of the leaf cells, chlorophyll is present?
   (a) stroma (b) Thylakoids
   (c) Plasma membrane (d) Cytoplasm
6. Which of these can enter into krebs cycle?
   (a) Glucose (b) Pyruvic acid
   (c) citric acid (d) Acetyl Co – A
7. When we work hard we suffer from muscle fatigue because muscle cells
   (a) Carry out aerobic respiration at faster rate and so are tired
   (b) Carry out anaerobic respiration and so accumulate more CO_2
   (c) Carry out anaerobic respiration and so accumulate lactic acid
   (d) Carry out aerobic respiration at faster rate and so accumulate lactic acid
8. How many molecules of CO_2 are produced when krebs cycle operates once?
   (a) 01 (b) 02
   (c) 03 (d) 06
9. The potential energy is stored in chemical bonds and is released as_____energy when these bonds break.
   (a) Heat (b) Light
   (c) Kinetic (d) Solar
10. Fungi and _____ bacteria get the prepared food.
    (a) Motile (b) Non-motile
    (c) Photosynthetic
    (d) Non-photosynthetic
11. _____ reactions are the direct source of energy.
    (a) Oxidation (b) Redox
    (c) Reduction (d) None
12. Redox reactions involve exchange of _____.
    (a) Electrons (b) Protons
    (c) Neutrons (d) Atoms

13. In living organisms, redox reactions involve the loss and gain of _____ atom.
(a) Oxygen (b) Carbon
(c) Nitrogen (d) Hydrogen

14. The major energy currency of all cells is:
(a) ADP (b) ATP
(c) AMP (d) P-bonds

15. Ribose is a _____ carbon sugar.
(a) Two (b) Three
(c) Five (d) Ten
(Lahore board 2011 G I)

16. There are _____ P-bonds in an ATP molecule.
(a) Two (b) Nine
(c) Six (d) Four

17. The breaking of one phosphate bond releases ___ kcal/mole of ATP.
(a) 7.9 (b) 7.5
(c) 7.1 (d) 7.3

18. Photosynthesis is a /an_____ process.
(a) Metabolic (b) Catabolic
(c) Anabolic (d) Chemical

19. _____ is an inorganic compound of carbon which have poor energy value.
(a) Glucose (b) CO_2
(c) ATP (d) NADPH

20. _____ is a co-enzyme.
(a) NAD^+ (b) NADH
(c) AMP (d) None

21. The raw materials in photosynthesis are
(a) Water, Oxygen (b) CO_2, O_2
(c) Water, CO_2 (d) Glucose,Water

22. The water from the soil enters into the root hairs by the process of
(a) Photosynthesis (b) Osmosis
(c) Diffusion (d) Respiration

23. The air enters the leaf through _____.
(a) Pits (b) Stomata
(c) Mesophyll (d) Xylem vessels

24. The light reactions of photosynthesis take place on the _____ of chloroplasts.
(a) Stroma
(b) Thylakoid membrane
(c) Lumen (d) Sacs

25. The reactions which do not require light during photosynthesis are called _____reactions.
(a) Chemical (b) Redox
(c) Dark (d) Light

26. Electrons are passed to ETC to produce:
(a) AMP (b) ATP
(c) ADP (d) NAD^+

27. The 6-carbon compounds during the dark reactions of photosynthesis split into _____ carbon compound.
(a) 5 (b) 3
(c) 7 (d) 4

28. How many percent of the light falling on the leaf surface is absorbed;
(a) 5% (b) 6%
(c) 7% (d) 1%

29. Exchange of water vapours and gases occurs in leaf through;
(a) Stomata (b) Epidermis
(c) Xylem (d) Phloem

30. Any environmental factor, the absence or deficiency of which can decrease the rate of a metabolic relations known as;

(a) Unlimited factor
(b) Limiting factor
(c) Both (d) None

31. Vessels, which transport water and salts to the plant are the components of:-
(a) Xylem (b) Phloem
(c) Vascular tissues (d) All

32. Photosynthesis takes place in:
(a) Chloroplasts (b) Cytoplasm
(c) mitochondria (d) All

33. Final products of anaerobic respiration is:
(a) Lactic acid (b) Ethanol
(c) CO_2 (d) All

34. Glycolysis occurs in:
(a) Cytoplasm (b) Stroma
(c) Nucleus (d) All

35. Fungi Aspergillus is used for making:
(a) Yogurt (b) Cheese
(c) Soy Sauce (d) Baking

36. Pyruvic acid is a_____Carbon compound.
(a) 5 (b) 4
(c) 3 (d) 2

37. In which of the following metabolic process, oxidation as well as reduction of molecules occur?
(a) Photosynthesis (b) Respiration
(c) Both (d) None of these

38. Chlorophyllous pigment absorbs maximum light in wavelengths of:
(a) Green and blue
(b) Green and red
(b) Green only
(d) Red and blue **(Lahore board 2011 G I)**

39. ATP was discovered by:
(a) Schwann (b) J.Purkinji
(c) Darwin (d) Karl Lohmann
(Lahore board 2011 G II)

Answers

1.	b	6.	d	11.	a	16.	a	21.	c	26.	b	31.	a	36.	C
2.	c	7.	c	12.	a	17.	d	22.	b	27.	b	32.	a	37.	c
3.	d	8.	b	13.	d	18.	c	23.	b	28.	d	33.	d	38.	d
4.	a	9.	c	14.	b	19.	b	24.	b	29.	a	34.	a	39	d
5.	b	10	d	15.	c	20.	a	25.	c	30.	b	35.	c		

Short Questions

Q.1. What is acetyl CO A?

Ans. Before entering in krebs cycle, pyruvic acid combines with coenzyme A and changed into a 2- Carbon Compound called acetyl Co-A.

Q.2. What is Adenine?

Ans. It is a double-ringed nitrogenous base used in the molecular structure of ATP.

Q.3. What is ADP?

Ans. ADP stands for Adenosine Diphosphate. When terminal bond of ATP is broken, a large amount of energy is released and ATP is converted into ADP. The breaking of one phosphate bond releases about 7300 calories per mole of energy.

Adenosine – PO_4 – PO_4 – PO_4 = ATP

Adenosine – PO_4 – PO_4 $\longrightarrow$ ADP +Pi + 7.3 K Cal/mole

Q.4. Define Aerobic respiration. **(Lahore board 2011 G II)**

Ans. A type of respiration in which glucose is completely oxidized by free form of oxygen and as a result, 686000 calories per mole energy is released.

Q.5. What is Alcoholic fermentation? **(Lahore board 2011 G I)**

Ans. In this type of anaerobic respiration, Pyruvic acid is further broken down into alcohol (C_2H_5OH) and CO_2.

Pyruvic Acid $\longrightarrow$ Ethyl alcohol + Carbon dioxide

2ATP molecules of energy are produced. It occurs in bacteria and yeast.

Q.6. What is AMP?

Ans. AMP stands for adenosine monophosphate. ADP is broken down to AMP and Pi is released.

ADP +H_2O $\longrightarrow$ AMP + Pi + energy 7.3 (KCal / mole)

Q.7. Define Anabolism.

Ans. There are certain constructive chemical reactions in which smaller molecules combine together to form complex structures which occur in our bodies. These are called anabolic reactions and the process is called anabolism e.g. photosynthesis and assimilation of food.

Q.8. Define Anaerobic respiration (Fermentation).

Ans. Some organisms oxidize their food incompletely without using any molecular oxygen called anaerobic respiration. It is of two types:

(ii) Lactic acid fermentation.

(iii) Alcoholic fermentation.

Q.9.What is ATP? **(Lahore board 2011 G I)**

Ans. ATP is abbreviation of adenosine tri-phosphate. It contains adenosine and three phosphates.

Adenosine and – PO_4 – PO_4 – PO_4

ATP is energy currency. It is a packet of energy produced in mitochondria by oxidation of glucose.

Q.10. What do you mean by the term Autotrophic?

Ans. The term autotrophic is applied to those organisms which can prepare their own food with the help of chlorophyll (photosynthesis) are called autotrophic.

Examples:

Green Plants, algae, some bacteria.

Q.11. Define bioenergetics.

Ans. Bioenergetics is the study of energy relationships and energy transformations (conversions) in living organisms.

Q.12. What is Calvin cycle?

Ans. Calvin cycle is also called dark reaction. Dark reaction is second phase of photosynthesis. It does not require light energy. In this reaction, glucose is synthesized in the absence of sunlight but energy required is obtained by NADPH and ATP formed during light reaction.

Q.13. What is Chlorophyll?

Ans. Chlorophyll is a green pigment inside the chloroplasts of plant cells. It enables plants to capture solar radiations to convert them into chemical energy of glucose.

Q.14. Define Coenzyme –A.

Ans. The enzyme which combines with pyruvic acid to form acetyl COA before entering krebs cycle is called coenzyme A.

Q.15. Define Electron Transport Chain (ETC). **(Lahore board 2012 G II)**

Ans. The final phase of cellular respiration in which the compounds NADH and $FADH_2$ are oxidized and their electrons pass along a chain of oxidation reduction steps to produce ATP. This chain is called Electron Transport Chain.

Q.16. What is FAD?

Ans. Flavin adenine dinucleotide (FAD) is also a coenzyme like NAD^+. It gets 2 hydrogen and reduces to $FADH_2$

Q.17. What is Glycolysis?

Ans. It is the first stage of aerobic respiration. In glycolysis, glucose is converted into Pyruvic acid. It occurs in cytoplasm and Oxygen is not involved in this stage.

Q.18. What is Krebs cycle?

Ans. It is the second stage of aerobic respiration. In krebs cycle, the Pyruvic acid molecules are completely oxidized into CO_2 and H_2O.

Q.19. What is Lactic acid Fermentation?

Ans. Introduction

It is a type of anaerobic respiration. Each Pyruvic acid molecule is converted into lactic acid ($C_3H_6O_3$).

Pyruvic acid ⟶ Lactic acid

Occurrence

It occurs in skeletal muscles of humans and other animals during extreme physical activities when Oxygen cannot be transported to the cells as rapidly as it is needed. This also happens in the bacteria present in milk.

Q.20. Define light-dependent reactions. **(Lahore board 2012 G I)**

Ans. Light dependent reaction (light reaction): During the first phase of Photosynthesis, light energy is captured and is used to make high energy molecules i.e. ATP and NADP. It takes place in thylakoid membranes of chloroplast.

These reactions take place in the stroma of the chloroplast.

Q.21. What are limiting factors?

Ans. Any environmental factor, the absence or deficiency of which can decrease the rate of a metabolic reaction is called limiting factor.

Q.22. What is Mesophyll?

Ans. The inner tissues of a leaf whose cells are green because they contain chloroplast (chlorophyll) is called mesophyll. The process of photosynthesis occurs here.

Q.23. Define Metabolism. **(Lahore board 2012 G II)**

Ans. The sum of all chemical processes (reaction) (Anabolism + Catabolism) taking place in living organisms is called metabolism.

Q.24. NADPH stands for what?

Ans. NAD (Nicotinamide adenine dinucleotide) is a co-enzyme that takes phosphate and hydrogen ions and is thus reduced to NADPH.

Q.25. Define Oxidation and Reduction reactions.

Ans. Oxidation: Addition of oxygen, removal of hydrogen or the loss of electrons is called oxidation. Oxidation is energy yielding process.

Reduction: Addition of hydrogen, removal of oxygen or the gain of electrons is called reduction. Reduction is energy consuming process

Q.26. Define photolysis.

Ans. (Photo: Light, lysis: breakdown) the breakdown of water molecules in the presence of light to release oxygen is called photolysis. Photolysis occurs in the light reaction (1^{st} phase) of photosynthesis.

Q.27. Define photosynthesis. **(Lahore board 2011 G II)**

Ans. Definition: The process by which plants and some other autotrophic organisms prepare their food (in the form of glucose) in the presence of sunlight and chlorophyll is called photosynthesis.

OR

"Photosynthesis is the synthesis of glucose from CO_2 and water in the presence of sun light and chlorophyll with O_2 as a by-product."

OR

"In this process, the energy-poor inorganic oxidized compounds of carbon (i.e. CO_2) are reduced to energy rich carbohydrates (i.e. "glucose")

Chemical Equation:

$$6CO_2 + 12H_2O + \text{Photon(sunlight)} \xrightarrow{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

It is an anabolic process and nearly all life depends on it.

Q.28. What are photosystems?

Ans. Photosynthetic pigments are organized into clusters for efficient absorption and utilization of solar/light energy in thylakoid membranes. These clusters are called photosystems.

Q.29. What are Pigments?

Ans. Pigments are the coloured substances that absorb visible light. Different pigments absorb light of different wavelengths. Chlorophyll a, chlorophyll b and carotenes are pigments effective for photosynthesis.

Q.30. What is pyruvic acid?

Ans. In the first step of respiration, a molecule of glucose (6-C) is broken down into two molecules of pyruvic acid. It is a 3-C Compound.

Q.31. What is respiration?

Ans. The oxidation of food in order to obtain energy is called respiration. The respiration takes place in a cell called cellular respiration.

Q.32. What is stroma?

Ans. Stroma: Chloroplast has a double membrane envelope that encloses dense fluid-filled region called stroma which contains most of the enzymes required to produce carbohydrate molecules.

Q.33. What is Thylakoid?

Ans. Another system of membranes is embedded in the stroma of chloroplast. These membranes form an interconnected set of flat, disc like sacs called thylakoids.

Chlorophyll (and other photosynthetic pigments) are found embedded in the thylakoid membranes and give green colour to the plant.

Q.34. What do you mean by Z-scheme?

Ans. The path of electrons through the two photosystems during light reaction of photosynthesis is called Z-scheme due to its Z-shaped form. **OR**

The whole series of light reactions is called Z-scheme due to its Z-shaped form.

Q.35. What is Light Independent Reaction (Dark Reaction)? **(Lahore board 2012 G I)**

Ans. Light Independent Reaction: During the second phase of photosynthesis, CO_2 is reduced to make glucose. The energy in the light form of ATP is utilized and stored in the

bonds of glucose. Since these reactions do not use light directly, they are known as light independent reactions.

Q.36. What are redox reactions?

Ans. Oxidation reduction reactions (involve exchange of electrons occur simultaneousley) are also called redox reactions.

Q.37. Who discovered ATP and who proposed it as energy-transfer molecule in the living cell?

Ans. Karl Lohmann discovered ATP in 1929 and Fritz Lipmann in 1941 proposed it as energy transfer molecule in living cell.

Q.38. Enlist the functions which are performed / carried out due to ATP?

Ans. Majority of the cellular functions are carried out due to ATP like the synthesis of macromolecules (DNA, RNA, Proteins), movement, transmission of nerve impulses, active transport, exocytosis and endocytosis etc.

Q.39. How much energy is released when one phosphate bond breaks in an ATP molecule?

Ans. 7.3 kilo calories / mole or 7300 calories / mole of ATP is released when one phosphate bond breaks.

Q.40. What is the major energy currency in all living cells?

Ans. ATP i.e Adenosine Triphosphate is the major energy currency in all living cells.

Q.41. What are the conversion equations for ATP to AMP?

Ans. Following are the conversion equations for ATP to AMP:

(i) $ATP + H_2O \longrightarrow ADP + Pi + energy(7.3kcal/mole)$

(ii) $ADP + H_2O \longrightarrow AMP + Pi + energy(7.3kcal/mole)$

Q.42. Write the general equation for photosynthesis.

Ans. $6CO_2 + 12H_2O + Photons \xrightarrow{Chlorophyll} C_6H_{12}O_6 + 6O_2 + 6H_2O$

Q.43. What are the raw materials for photosynthesis?

Ans. CO_2 and water are the raw materials for photosynthesis.

Q.44. Define Osmosis.

Ans. Osmosis is the movement of water molecules from a region of dilute solution to the region of concentrated solution through a selectively permeable membrane.

Example:

The movement of water molecules along with salts from the soil into the roots and root hairs takes place through osmosis.

Q.45. How much the leaf surface is covered by stomata?

Ans. Stomata covers only 1-2% of the leaf surface.

Q.46. What are the locations for the occurrence of light and dark reactions?

Ans. Light reactions takes place on the thylakoid membranes of the chloroplast.

Dark reaction takes place in the stroma of the chloroplast.

Q.47. ATP, ADP and AMP stands for what?

Ans. ATP: Adenosine Triphosphate ADP: Adenosine Diphosphate
AMP: Adenosine Monophosphate

Q.48. What are Vascular tissues?

Ans. Conducting tissues in plants are called vascular tissues.

i. Xylem

Xylem transport salts and water from roots to different parts of the plants.

ii. Phloem

Phloem used for the conduction of food from leaves to the different parts of the plants.